Tokuo

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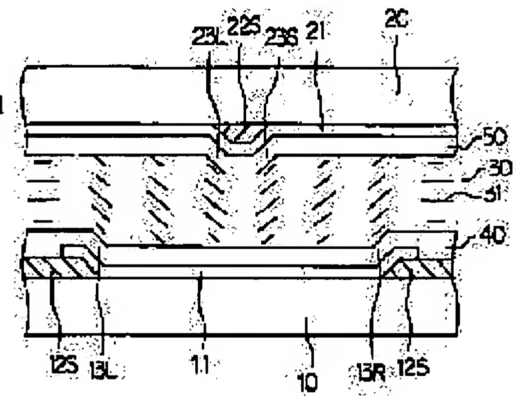
(54) LIQUID CRYSTAL DISPLAY DEVICE

(57)Abstract:
PURPOSE: To provide a liquid crystal display device of a wide visual field angle by dividing display pixels and specifying orientation vectors of liquid crystal directors.
CONSTITUTION: This liquid crystal display device has the following structure, in which inclined parts 13L, 13R for orientation control are formed by interposing section layers 12 for orientation control in the lower layers at the peripheral edges of the display pixel regions of lower transparent electrodes 11 to build up the contact surfaces with a liquid crystal layer 30 and inclined parts 23L, 23R for orientation control are also formed by interposing sectional layers 22S for orientation control in the lower layers within the display pixel regions of upper transparent electrodes 21. The orientation directions of the liquid crystal directors 31 are controlled by these inclined parts 13L, 13R, 23L, 23R and the orientation states are made uniform in the respective zones divided into the right and left zones by the effect of the continuum characteristic of the liquid crystals. In addition, the dependency on the visual angles is lessened by making the orientation vectors of respective zones different from each other.



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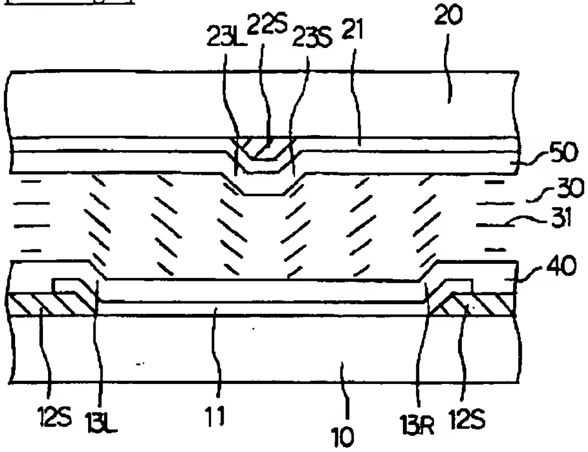
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the cross section of the LCD concerning the 1st example of this invention.
[Drawing 2] It is the plan of the LCD concerning the 1st example of this invention.
[Drawing 3] It is the cross section of the LCD concerning the 2nd example of this invention.
[Drawing 4] It is the plan of the LCD concerning the 2nd example of this invention.
[Drawing 5] It is the cross section of the LCD concerning the 3rd example of this invention.
[Drawing 6] It is the plan of the LCD concerning the 3rd example of this invention.
[Drawing 7] It is the cross section of the LCD concerning the 4th example of this invention.
[Drawing 8] It is the plan of the LCD concerning the 4th example of this invention.
[Drawing 9] It is the cross section of the LCD concerning the 5th example of this invention.
[Drawing 10] It is the plan of the LCD concerning the 5th example of this invention.
[Drawing 11] It is the cross section of the LCD concerning the 6th example of this invention.
[Drawing 12] It is the plan of the LCD concerning the 6th example of this invention.
[Drawing 13] It is the cross section of the LCD concerning the 7th example of this invention.
[Drawing 14] It is the plan of the LCD concerning the 7th example of this invention.
[Drawing 15] It is the cross section of the LCD concerning the example of the octavus of this invention.
[Drawing 16] It is the plan of the LCD concerning the example of the octavus of this invention.
[Drawing 17] It is the cross section of the LCD concerning the 9th example of this invention.
[Drawing 18] It is the plan of the LCD concerning the 9th example of this invention.
[Drawing 19] It is the cross section of the LCD concerning the 10th example of this invention.
[Drawing 20] It is the plan of the LCD concerning the 10th example of this invention.
[Drawing 21] It is the plan of a matrix type LCD.
[Drawing 22] It is the plan of the active matrix liquid crystal display using TFT.
[Drawing 23] It is the cross section of the LCD of the conventional TN method.
[Drawing 24] It is the perspective diagram of the LCD of the conventional TN method.
[Drawing 25] It is the cross section of the LCD of the conventional ECB method.
[Drawing 26] It is drawing explaining the trouble of the LCD of the conventional TN method.
[Drawing 27] It is drawing explaining the trouble of the LCD of the conventional ECB method.
[Description of Notations]
10, 20,100,110 Transparent substrate
11, 21,101,111 Transparent electrode
12, 15, 22,102,105,112 Orientation control fault
13, 14, 16, 23, 25, 103, 104,106,113,115 orientation control ramp
17, 24,107,114 Orientation control aperture
30,120 Liquid crystal layer
31,121 Liquid crystalline director
40, 50,130,140 Orientation layer
U, D, L, R Display zone
X Scanning electrode
Y Data electrode
G Gate line
D Drain line
P Display electrode

[Translation done.]

DRAWINGS

[Drawing 1]



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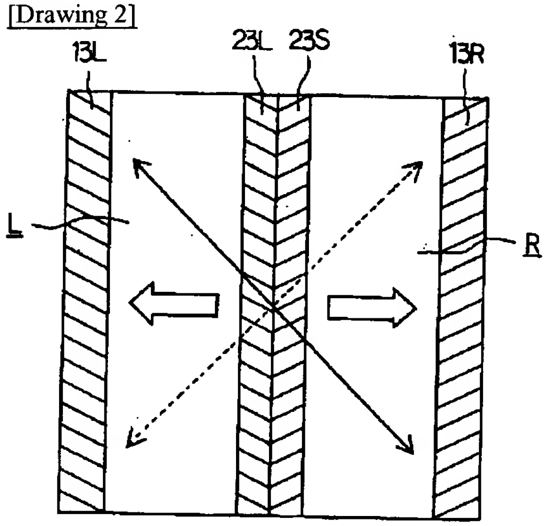

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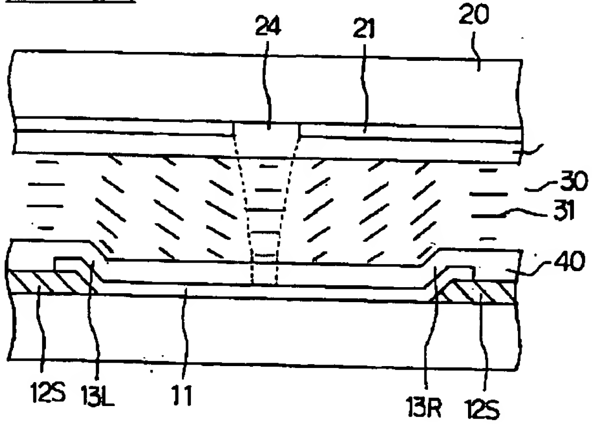
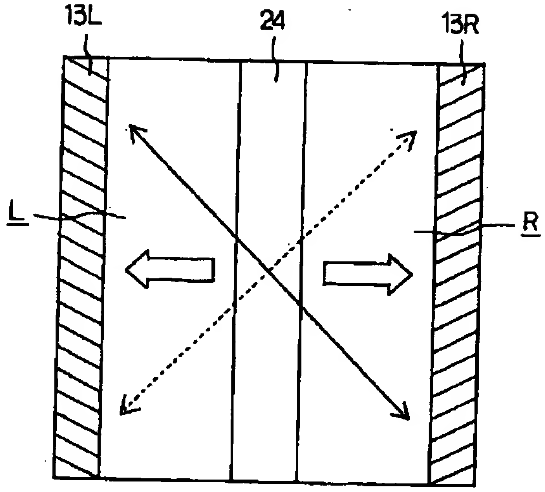


~~[Drawing 4]~~

Drawing 4:



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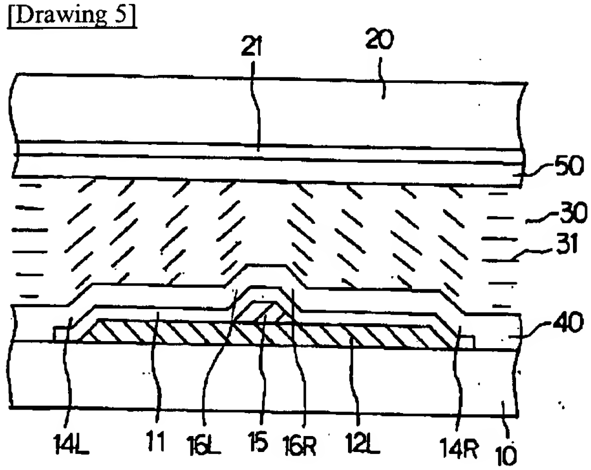

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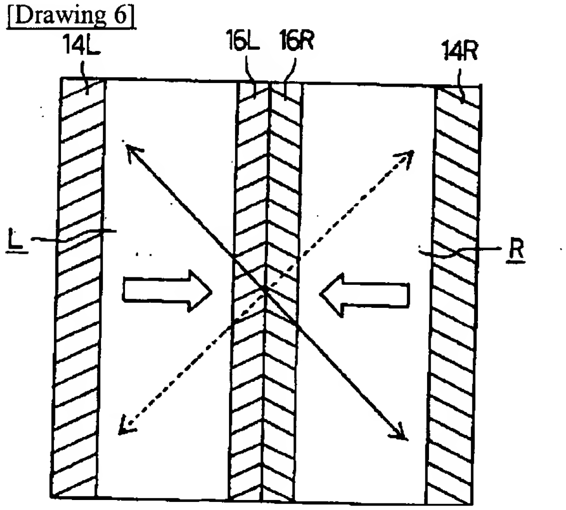
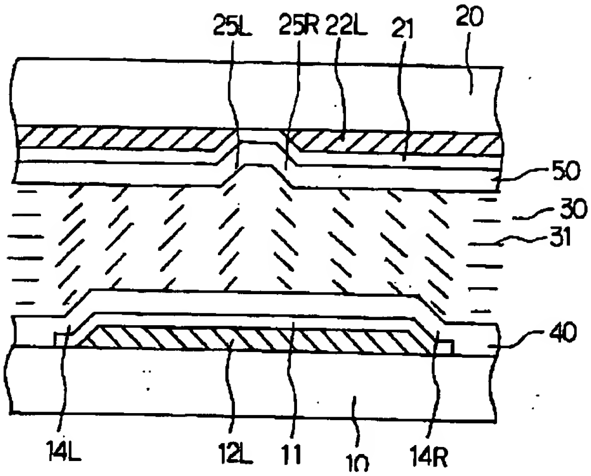
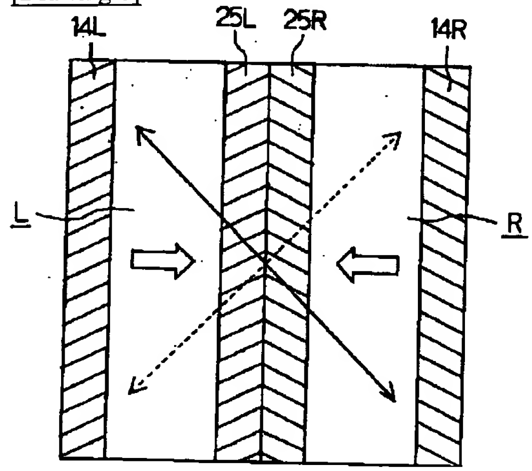


~~[Drawing 7]~~

Drawing 7:



[Drawing 8]



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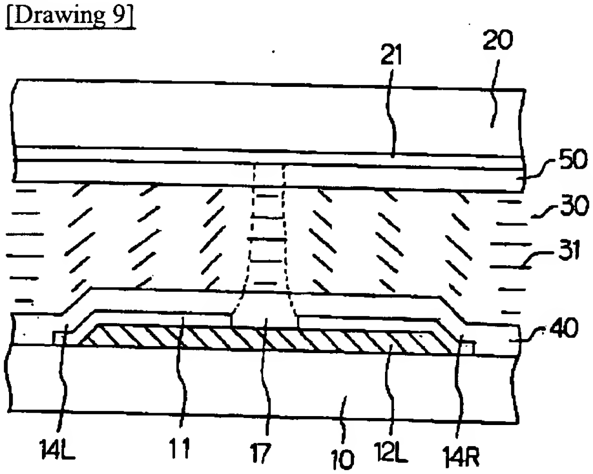
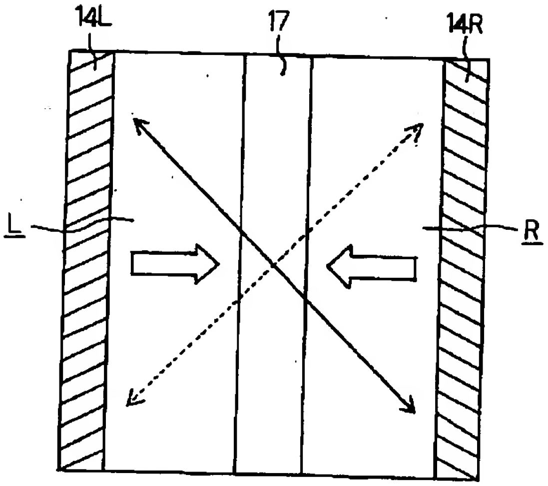
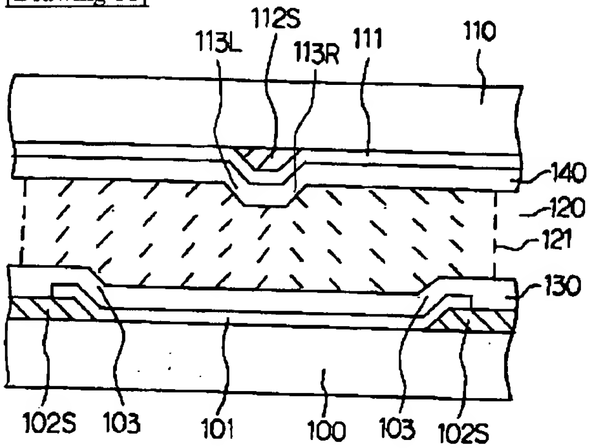


~~[Drawing 10]~~

Drawing 10 :



[Drawing 11]



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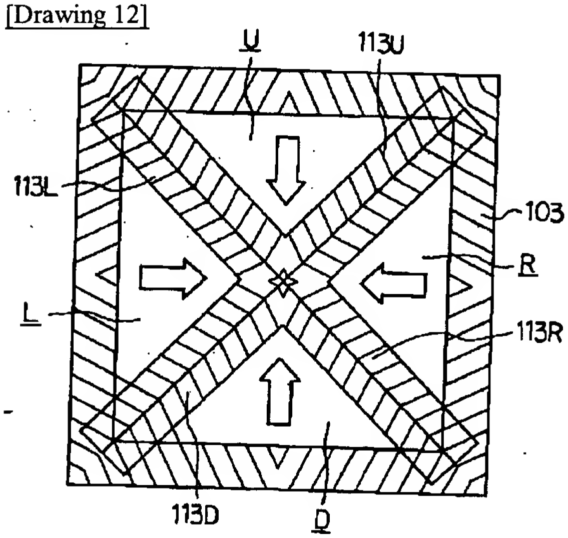
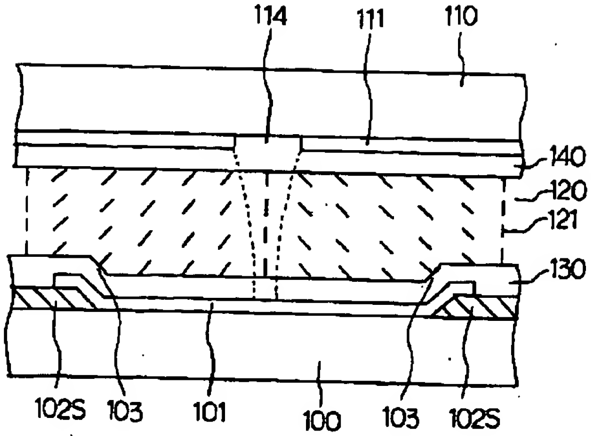


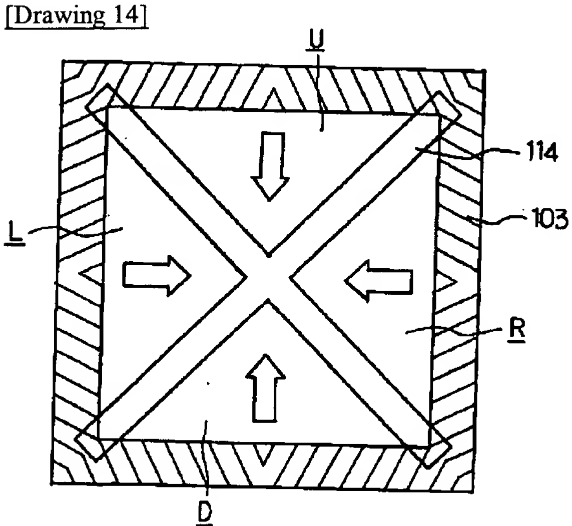
~~[Drawing 13]~~

Drawing 13:



7th example

[Drawing 14]



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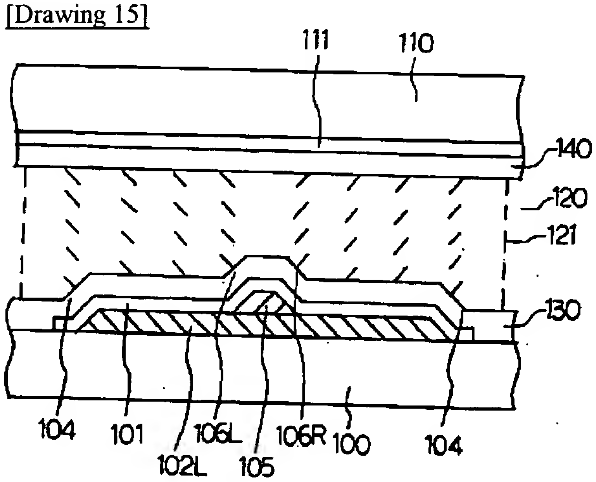
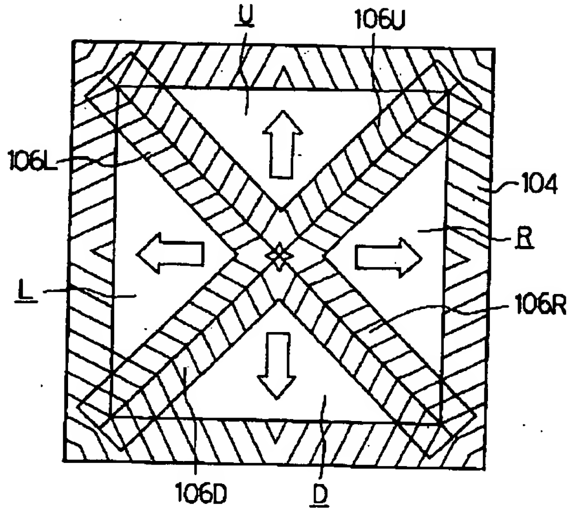
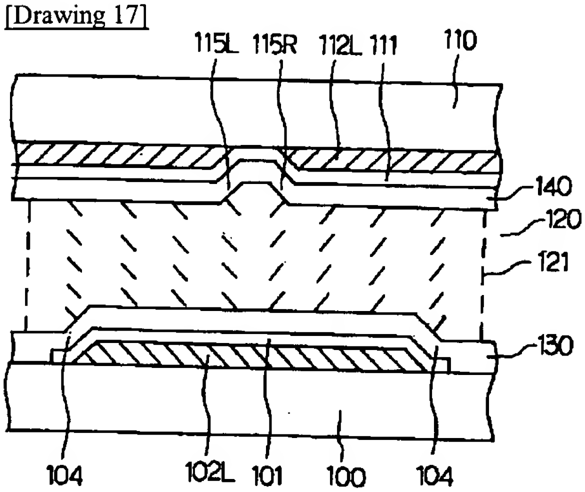


~~[Drawing 16]~~

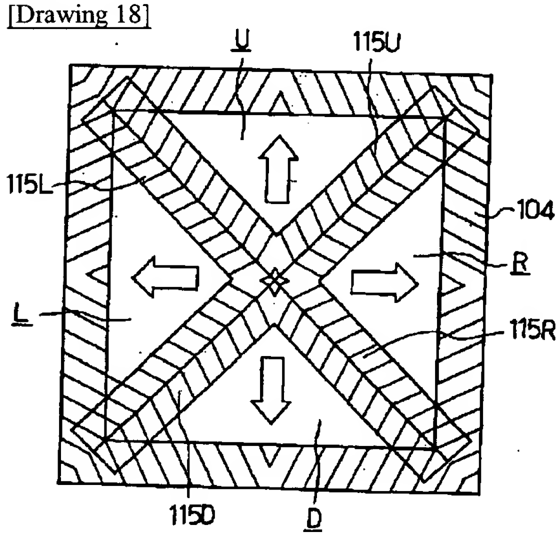
Drawing 16:



[Drawing 17]

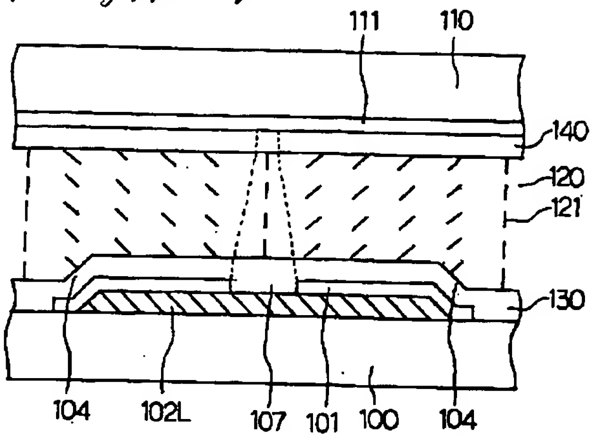


[Drawing 18]



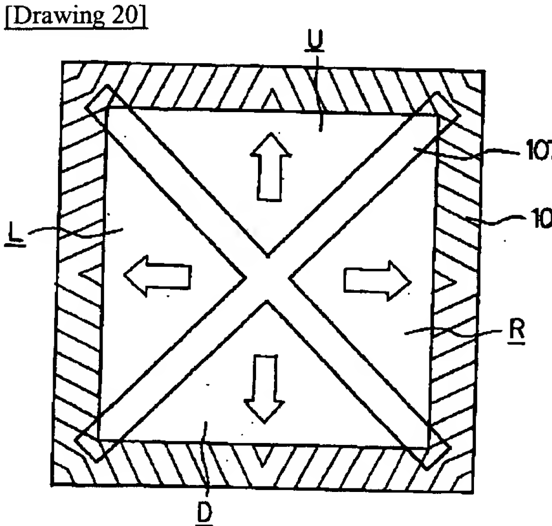
~~[Drawing 19]~~

: Drawing 19:

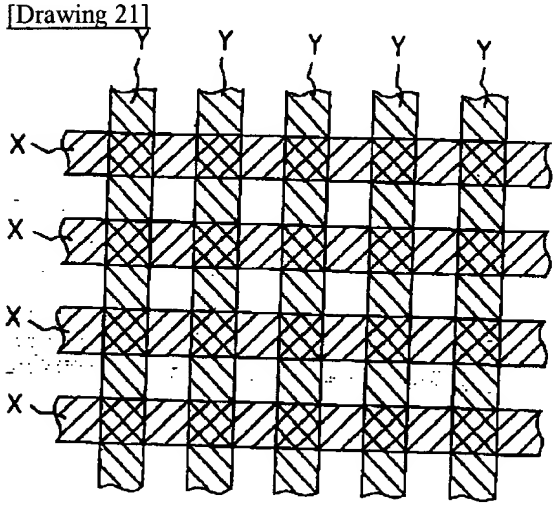


10th Example
Like 7th Example
only
bottom slot

[Drawing 20]

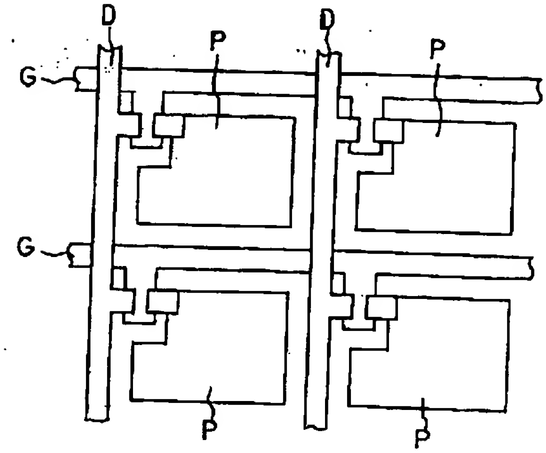


[Drawing 21]

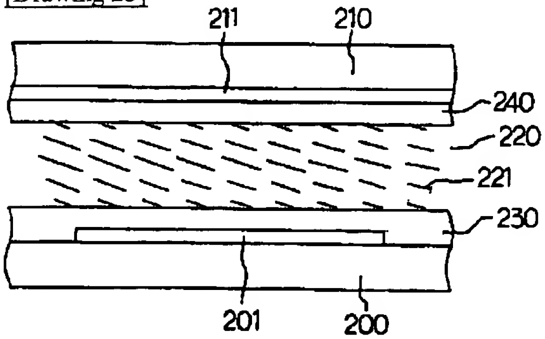


~~[Drawing 22]~~

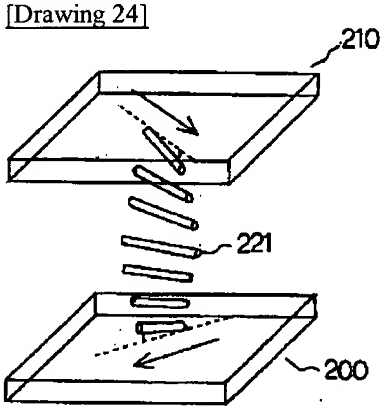
Drawing 22:



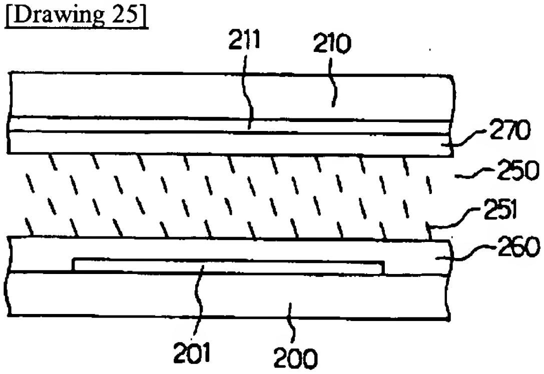
[Drawing 23]



[Drawing 24]

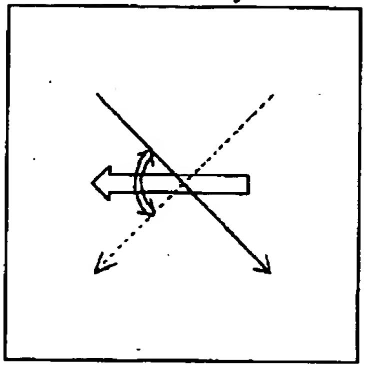


[Drawing 25]

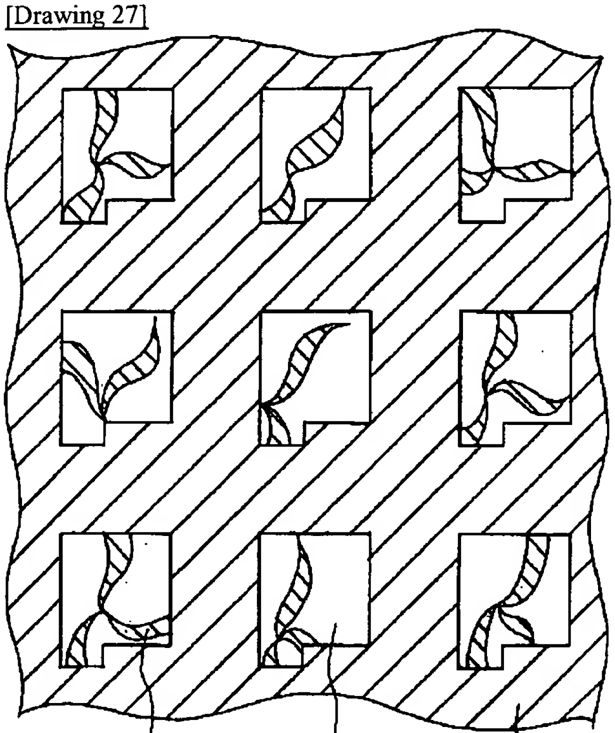


~~[Drawing 26]~~

Drawing 26 !



[Drawing 27]



[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] Especially this invention relates to the LCD which attained a wide-field-of-view angle property and high display quality by controlling the orientation of a liquid crystalline director about a LCD.
[0002]
[Description of the Prior Art] A LCD has advantages, such as small, a thin shape, and a low power, and utilization is progressing as a display unit in fields, such as OA equipment and an AV equipment. Two substrates in which the transparent electrode of a predetermined pattern was prepared are stuck on both sides of a liquid crystal layer with a thickness of micrometers [several] on transparent substrates, such as glass, and a LCD is constituted by putting this further with two polarizing plates with which a polarization shaft intersects perpendicularly mutually. The drive of several 10,000 to several 100,000 pixel is possible for especially the matrix type that drives liquid crystal by choosing arbitrarily the intersection which carried out transposition arrangement of a scanning electrode group and the data electrode group, and impressing a voltage to display pixel capacity, and it fits the big screen and the high definition display display unit.
[0003] The general planar structure is shown in drawing 21 . A scanning electrode (X) and a data electrode (Y) all consist of transparent electric conduction layers, such as ITO. these have been arranged up and down on both sides of liquid crystal, respectively -- glass -- ** -- it is formed on the transparent substrate and the crossover of two electrodes (X, Y) serves as display pixel capacity As for two electrodes (X, Y), a signal level is impressed by time-sharing drive. By impressing the effective voltage more than a threshold to the display pixel used as a choosing point, and driving liquid crystal, a set of the displaying point that permeability changed is checked by looking as display images, such as a character and an image.
[0004] Drawing 22 is the active matrix type planar structure which used TFT (Thin Film Transistor:thin film transistor) as a switching element for selection. In the active gore ****** type, the gate line for scanning signals (G) and the drain line for data signals (D) are formed on the same substrate. As a barrier layer, TFT which used non-single crystal semiconductor layers, such as a-Si and p-Si, is formed by the intersection of both lines (G, D), and it has connected with a display electrode (P) at it. The counterelectrode is completely formed on another [by which opposite arrangement was carried out on both sides of the liquid crystal layer] substrate, and each opposite fraction with a display electrode (P) serves as display pixel capacity. A display electrode (P) and a counterelectrode consist of transparent electric conduction layers, such as ITO. Scanning selection of the gate line (G) is carried out line sequential, it sets all TFT on the same scanning line to ON, and supplies the data signal which synchronized with this to each display electrode (P) through a drain line (D). Liquid crystal is driven also for a counterelectrode with the voltage difference with each display electrode (P) which a voltage is set up synchronizing with a scanning of a gate line (G), and counters, among un-choosing, the voltage impressed to display pixel capacity is held by OFF resistance of TFT, and the drive status of liquid crystal is continued.
[0005] Drawing 23 is a cross section having shown the cellular structure of such a LCD. On the transparent substrate (200,210), the transparent electrode (201,211) used as a scanning electrode, a display electrode and a data electrode, or a counterelectrode is formed, respectively, and it is located in the upper and lower sides whose liquid crystal layer (220) was pinched. Moreover, the orientation layer (230,240) which consists of poly membranes, such as a polyimide, on a transparent electrode (201,211) is covered, and the surface orientation is controlled by performing rubbing processing. Furthermore, although illustration was omitted, the polarizing plate is prepared in the outside of both substrates (200,210) so that polarization shaft orientations may intersect perpendicularly mutually.
[0006] A liquid crystal layer (220) is the nematic liquid crystal which mixed chiral material and gave the directivity of the orientation of torsion. Although orientation of the liquid crystal with the positive dielectric constant anisotropy is carried out in parallel [with a substrate front face] in this way, it will be in the initial orientation status with few initial inclination (pre tilt) angles along the orientation of rubbing. In the orientation in which rubbing intersects perpendicularly mutually about both substrates (200,210), among vertical both substrates, a line crack and liquid crystal are twisted at 90 degrees, and are arranged. Drawing 24 is a perspective diagram having shown this mode typically. Rubbing processing of vertical both the substrates is carried out in the orientation shown by the arrow head, respectively. By the contact surface, a liquid crystalline director (221) is started by the pre tilt in the orientation of rubbing, according to this, is twisted clockwise upwards and arranged from the bottom upwards. The such type LCD is called TN (Twisted Nematic: it can twist and nematic) method. By impressing a voltage to a liquid crystal layer (220), being twisted to it, and canceling the status, the transmitted light is controlled by TN method and light and darkness (black and white) have been obtained in it.
[0007] Drawing 25 is a cell using the liquid crystal with the negative dielectric constant anisotropy as a liquid crystal layer (250). Although change with TN method shown in drawing 23 and there is no electrode disposition, it is the cell which carried out initial orientation of the liquid crystal to the perpendicular direction of a substrate by the excluded volume effect of the orientation layer (260,270) formed for perpendicular orientation. When a liquid crystalline director (251) arranges this in parallel

to the macromolecule component of the orientation layer (260,270) which grew perpendicularly to the substrate, the mutual excluded volume produced by contact of the occupied volume of a macromolecule and the occupied volume of a liquid crystal molecule is made to become the minimum. As such a type, the orientation of liquid crystal is changed from an initial state for example, by electric-field impression, and there is an ECB (Electrically Controlled Birefringence) method which obtains light and darkness and the color by giving birefringence change to an incident light.

[0008]

[Problem(s) to be Solved by the Invention] Then, the trouble of the conventional LCD is explained. Drawing 26 is drawing which projected the orientation of a liquid crystalline director superficially, when TN cell is seen from a top. The dotted-line arrow head is the lower orientation of rubbing, and the solid-line arrow head is the upper orientation of rubbing. A liquid crystalline director (221) turns upwards the orientation shown by the dotted-line arrow head, starts, with the up side, turns downward the orientation shown by the solid-line arrow head, and starts with the down side so that it may understand, even if it refers to drawing 24 . When the sense of an orientation vector is taken to the facing up of the orientation of a major axis of liquid crystal, all the liquid crystalline directors in a cell have the orientation vector of angle within the limits shown by the double arrow head. In the interlayer of liquid crystal in halftone, it is considered that a liquid crystalline director is expressed with the orientation vector shown by ******, and is in the status of this orientation vector on the average also a whole floor tone and in all] a liquid crystal layer. Since the orientation status of liquid crystal over an optical path also changed with change of a viewing angle relatively, as compared with the check by looking from the front, in the check by looking from the right-hand side of space, gradation approached white, black was approached by the check by looking from left-hand side, and the viewing-angle dependency of a longitudinal direction was high.

[0009] Drawing 27 is a plan having shown the transparency status of the light at the time of a drive of the LCD of the conventional perpendicular orientation type ECB method. Although omitted in the upper explanation, usually, shading layers, such as metal, are prepared in the opposite substrate side, and transparency of light is intercepted except for opening (300) corresponding to the pixel by which matrix arrangement was carried out. In this shading field (301), the optical leakage between pixels is prevented, it becomes black, and the contrast ratio of a display is improved. Although the permeability of light will be controlled by each opening (300) and a desired display will be obtained, the black field called disclination (302) is generated also in this opening (300). Disclination is a field where the orientation of a liquid crystalline director shows ****** and the permeability from which other fields are different on the boundary line, when two or more fields in which the orientation vector of liquid crystal is mutually different exist.

[0010] The liquid crystalline director of a nematic phase is restricted only at an angle [as opposed to the orientation of the electric field in the orientation vector at the time of voltage impression], and the azimuth centered around the orientation of the electric field is released. Therefore, the field where the orientation vector changed mutually with causes, like that the irregularity by the electrode is shown in a substrate front face, and surface-orientation processing is uneven or the electric field of the longitudinal direction by the inter-electrode potential difference in a cell exist is generated. If the abnormalities of an orientation vector exist also partially, for the continuum nature of liquid crystal, it will cross to the field with the orientation vector which has an azimuth which follows this, and will spread. If such a thing breaks out by two or more places of a cell, though the angle with the orientation of the electric field to make is the same, two or more fields which have the orientation vector from which an azimuth is different will be generated. Permeability differs from others and the boundary line of these fields serves as disclination. If the disclination of a configuration different for every pixel occurs frequently, a rough deposit will arise on a screen or problems -- the color display of an expectation is not obtained -- will be caused.

[0011] Moreover, when the orientation vector of each field becomes irregular in a viewing area, there is a problem in which a viewing-angle dependency increases. Furthermore, the threshold of TFT and the problem of the so-called electrostatic discharge which causes change of a mutual conductance also have static electricity produced at the time of rubbing.

[0012]

[Means for Solving the Problem] In view of the above technical probrem, accomplish this invention, and two substrates with the transparent electrode are stuck on an opposite front-face side up and down on both sides of a liquid crystal layer the 1st. In the LCD which comes to arrange the display pixel formed in the opposite section of two electrodes in the shape of a matrix It is the configuration which the orientation control ramp formed by upheaving or collapsing partially the contact front face with the aforementioned liquid crystal layer in the periphery of one [at least] aforementioned display pixel of the aforementioned electrode or/, and the field is prepared, and controlled the orientation of liquid crystal by this orientation control ramp.

[0013] It is the configuration that the aforementioned electrode was formed by upheaving partially in the 1st aforementioned configuration the 2nd of the orientation control fault in which the aforementioned orientation control ramp was prepared in the lower part of the aforementioned electrode. It is the configuration of the aforementioned orientation control ramp having been prepared in the field of the aforementioned display pixel, having divided the aforementioned display pixel into the 3rd at two or more fractions, and having changed the orientation of the liquid crystal of each fraction of the divided aforementioned display pixel in the 1st aforementioned configuration in it.

[0014] It is the configuration which controlled further the orientation of the liquid crystal which the orientation control aperture formed of the absence of an electrode was prepared in the field of one [at least] aforementioned display pixel of the aforementioned electrode in the 1st aforementioned configuration, and was controlled by the aforementioned orientation control ramp by the 4th.

[0015]

[Function] In the ramp which the substrate front face was upheaved or collapsed and formed it with the 1st aforementioned configuration, the orientation of initial orientation is controlled in parallel or perpendicularly to an inclined plane, and the liquid crystalline director which has a positive or negative dielectric constant anisotropy has it in the status that it had a predetermined angle, with the orientation of the electric field, respectively. For this reason, the inclination orientation is restricted so that it may incline toward the status stable in energy by the shortest by voltage impression, and an orientation vector is determined together

with the electric field effect based on a dielectric constant anisotropy.

[0016] Thus, if an orientation vector is determined by the orientation control ramp, the field with the same orientation vector will spread by it, until it is restricted to the fraction which received other operations [some], such as an electrode and other orientation control ramps, by the continuum nature of liquid crystal. For this reason, by arranging an orientation control ramp in a predetermined configuration all over the circumference of a display pixel field, and a field, in the zone specified by these operations, an orientation vector is arranged uniformly and a display property improves.

[0017] With the 2nd aforementioned configuration, by arranging an orientation control fault between layers in the lower part of an electrode, an electrode upheaves partially and the orientation control ramp to which the contact front face with a liquid crystal layer upheaved or caved in is formed. Since each zone in the display pixel field divided into the plurality with the 3rd aforementioned configuration by the orientation control ramp prepared in the field of a display pixel has the mutually different priority viewing-angle orientation, the priority viewing-angle orientation spreads about one display pixel, and it can reduce a viewing-angle dependency.

[0018] Since the electric field are below the thresholds of a liquid crystal drive weakly in the liquid crystal layer corresponding to this by having prepared the orientation control aperture which is the absent fraction of an electrode in the field of a display pixel with the 4th aforementioned configuration, a liquid crystalline director is held at the initial orientation status. An orientation control aperture is fixed uniformly, orientation is stabilized by the boundary of each zone of the liquid crystal layer controlled by the orientation status which changes with orientation control ramps, respectively, and its display property improves further.

[0019]

[Example] Hereafter, this invention is explained in detail based on an example. First, the 1st example is explained, referring to the drawing 1 and the drawing 2 . Drawing 1 is a cross section of TN liquid crystal cell concerning this example. On two transparent substrates (10, 20) stuck up and down on both sides of the liquid crystal layer (30), the transparent electrode (11, 21) which consists of ITO is prepared. It is placed between the lower parts of a lower transparent electrode (11) by the insulator, and the transparent electrode (11) is upheaved at the ends of the display pixel section as an orientation control fault (12S). On the other hand, it is placed also between the lower parts of an upper transparent electrode (21) by the insulator, and the transparent electrode (21) is upheaved inside [of the display pixel section] a field as an orientation control fault (22S). Each orientation control fault (12, 22) is formed by etching SiNX, SiO2, etc. On a transparent electrode (11, 21), the method vacuum evaporationo layer of slanting and LB film (Langmure-Blodgett film) of SiO are covered by the whole surface, respectively, and it has become the orientation layer (40, 50). Parallel orientation structure of 0 degree of pre tilt angles is realized by this orientation layer (40, 50). In the method vacuum evaporationo of slanting of SiO, the parallel orientation of 0 degree of pre tilt angles is acquired in orientation right-angled in the orientation of vacuum evaporationo by carrying out vacuum evaporationo at the angle of 60 degrees from the normal of a substrate. Moreover, LB film is a layer which made the substrate front face accumulate the monomolecular film which adsorbed on the water surface, and the parallel orientation layer of 0 degree of pre tilt angles is obtained in the orientation moved up and down by crossing the water surface and making a substrate go up and down in the perpendicular orientation as an orientation layer. By mixing chiral material, it is the nematic liquid crystal which has a positive dielectric constant anisotropy, and a liquid crystal layer (30) gives the ease of being twisted of a liquid crystalline director (31), in response to the control of an orientation layer (40, 50), it is twisted at 90 degrees and arranged among both substrates by the contact surface. The orientation layer (40, 50) serves as the orientation control ramp (13L, 13R, 23L, 23R) toward which the contact front face with a liquid crystal layer (30) inclined [the slant face of the fraction which upheaved by the orientation control fault (12S, 22S)].

[0020] A drive of the cell of this structure starts the liquid crystalline director (31) of each other from an opposite side in the field of right-and-left both sides according to the orientation control ramp (13L, 13R) of the both ends of a bottom electrode (11), respectively. Moreover, an opposite side starts by the orientation control ramp (23L, 23R) also in the center section of a top electrode (21), respectively. That is, while a liquid crystalline director (31) is altogether started by operation of the orientation control ramp (13L, 23L) of the upper and lower sides whose liquid crystal layer (30) was pinched in the zone on the left-hand side of drawing for the continuum nature of liquid crystal from left-hand side, a liquid crystalline director (31) is altogether started by operation of an orientation control ramp (13R, 23R) from right-hand side by it, in a right-hand side zone. Thus, while a display pixel is divided into two zones where an orientation vector is different by arranging an orientation control ramp (13L, 13R, 23L, 23R), it will be in the uniform orientation status in each zone.

[0021] Drawing 2 is a plan of the display pixel section, and shows the structure as which the opposite fraction of vertical two electrodes (10, 20) was regarded from the top. There is a strip region of a lower orientation control ramp (13L, 13R) along the side of right-and-left ends, and the center section which was parallel to this serves as the strip region of an upper orientation control ramp (23L, 23R). A dotted line is the orientation of orientation of a bottom substrate (10), and a solid line is the orientation of orientation of a top substrate (20). According to this, 90 degrees of liquid crystalline directors are rotating from the bottom clockwise to the bottom. ****** is the projection to the flat surface of halftone and the orientation vector in the interlayer of liquid crystal. In two zones (L, R) divided into right and left, the orientation vector is mutually turned to the opposite direction so that clearly from drawing. That is, an opposite side is started in the zone (L, R) of an initial state to the right and left which met in the orientation of parallel orientation where a liquid crystalline director is the same. Moreover, also about a vertical substrate, an opposite side is started and the continuity of a liquid crystalline director is made to become smooth. It can be considered that the orientation vector shown by ****** has a liquid crystalline director in this status on the average also about a whole floor tone and all the liquid crystal layers in the zone.

[0022] By such cellular structure, about the check by looking from the left of space, while the gradation of a zone (L) approaches black from the check by looking from a transverse plane, in order that the gradation of a zone (R) may approach white, the mean tone of both zones (L, R) approaches a check by looking from a transverse plane. Since there is an equalization operation with the same said of the check by looking from the right, the viewing-angle dependency of a longitudinal direction is reduced.

[0023] The 2nd to 5th example of this invention which controlled the orientation of a liquid crystalline director by the orientation

control ramp, divided the display pixel into the plurality, and reduced the viewing-angle dependency about TN liquid crystal cell of the parallel orientation structure which does not have a pre tilt angle in the nematic liquid crystal with the positive dielectric constant anisotropy as a liquid crystal layer like the 1st example hereafter using what mixed chiral material is explained.

[0024] (The 2nd example) Since this example is similar to the 1st example, a detailed explanation is omitted. Drawing 3 is a cross section of the cellular structure. Differing from the 1st example shown in drawing 1 is the point that the orientation control aperture (24) which is an electrode absent fraction is formed in the center section of a transparent electrode (21) instead of the orientation control ramp at the top substrate (20). Opening of the orientation control aperture (24) is carried out by etching etc. into a transparent electrode (21) after membrane formation of ITO. In the field corresponding to an orientation control aperture (24), the electric field do not arise in a liquid crystal layer (30), or it is feeble, and since it is below the drive threshold of liquid crystal, the liquid crystalline director (31) is being fixed to the early orientation status. Therefore, the boundary of two zones where an orientation vector is different is fixed by the orientation control aperture (24), and the orientation status controlled by the orientation control ramp (13L, 13R) of a bottom substrate (10) from the both sides of the display pixel section is divided by the continuum nature of liquid crystal.

[0025] In addition, although the orientation control aperture (24) has the absent electrode, the electrode exists in the field of the transparent electrode (11) of the bottom which counters this. For this reason, in the liquid crystal layer (30) corresponding to an orientation control aperture (24), the electric field arise in the orientation of slant in a configuration which is shown by the dotted line of drawing 3 . Although orientation of the liquid crystalline director (31) which has a positive dielectric constant anisotropy is carried out in the orientation of the electric field, an inclination is caused so that it may be suitable in the orientation of the electric field by the shortest from the initial orientation status. That is, in the field corresponding to the edge on the left-hand side of an orientation control aperture (24), a liquid crystalline director (31) is started from left-hand side, and a liquid crystalline director (31) is started from right-hand side in the field corresponding to the edge on the right-hand side of an orientation control aperture (24). Therefore, in this way, while a liquid crystalline director (31) is altogether started from left-hand side together with an operation of an orientation control ramp (13L) by preparing an orientation control aperture (24) in a top substrate (20) in the zone on the left of an orientation control aperture (24), together with an operation of an orientation control ramp (13R), a liquid crystalline director (31) is altogether started from right-hand side in the zone on the right of an orientation control aperture (24).

[0026] A plan is shown in drawing 4 . In two zones (L, R) divided by the orientation control aperture (24), an opposite side is started like the 1st example shown in drawing 2 , respectively from the initial state which met in the orientation of parallel orientation where a liquid crystalline director is the same. Therefore, since the check by looking from a longitudinal direction is recognized by the mean tone of both zones (L, R), a viewing-angle dependency is reduced.

[0027] (The 3rd example) The cross-section structure of a cell is shown in view 5 . On two transparent substrates (10, 20) stuck up and down on both sides of the liquid crystal layer (30), the transparent electrode (11, 21) which consists of ITO is prepared. The orientation control fault (12L) formed in the great portion of display pixel section and the 2nd orientation control fault (15) formed in the interior of the display pixel section on an orientation control fault (12L) are prepared in the lower part of a lower transparent electrode (11). On both transparent electrodes (11, 21), the orientation layer (40, 50) which consists of the method vacuum evaporationo layer of slanting and LB film of SiO, respectively is covered by the whole surface. On the whole, in the transparent electrode (11), with **********, a transparent electrode (11) caves in relatively, a slant face produces the ends of the display pixel section where an orientation control fault (12L) is absent on an orientation layer (40), and the orientation control fault (12L) serves as the orientation control ramp (14L, 14R). Moreover, the 2nd orientation control fault (15) upheaves a transparent electrode (11) in part, and the slant face of an orientation layer (40) serves as the orientation control ramp (16L, 16R) also in this fraction.

[0028] A display pixel field is divided into the zone of the left-hand side specified by the orientation control ramp (14L, 16L), and the zone of the right-hand side specified by the orientation control ramp (14R, 16R). That is, in a left-hand side zone, a liquid crystalline director (31) is altogether started from right-hand side according to an orientation control ramp (14L, 16L), and a liquid crystalline director (31) is altogether started from left-hand side in a right-hand side zone.

[0029] The plan of the display pixel section is shown in drawing 6 . There is a strip region of an orientation control ramp (14L, 14R) along the side of the right-and-left ends of a display pixel, and the strip region of an orientation control ramp (16L, 16R) is in this and parallel in the center of a display pixel. Thus, in two zones (L, R) divided into right and left, the flat-surface projection of the average orientation vector as which a liquid crystalline director has an opposite side started, and is expressed in ****** from the same parallel orientation status, respectively has turned to the opposite direction.

[0030] By such cellular structure, about the check by looking from the left of space, while the gradation of a zone (L) approaches white from the check by looking from a transverse plane, in order that the gradation of a zone (R) may approach black, the mean tone of a zone (L, R) approaches a check by looking from a transverse plane. Since there is an operation with the same said of the check by looking from the right, the viewing-angle dependency of a longitudinal direction is reduced.

[0031] (The 4th example) That this example differs from the 3rd example is the point that the orientation control ramp (25L, 25R) is prepared in the top substrate (20) as a split means of a display pixel, as shown in drawing 7 . It is placed between the lower parts of a lower transparent electrode (11) by the orientation control fault (12L) formed in the great portion of display pixel section, and the slant face of an orientation layer (40) has become them with the orientation control ramp (14L, 14R) at right-and-left both ends. An orientation control fault (22L) is prepared in the lower part of an upper transparent electrode (21) at the great portion of display pixel section, it travels through the center section of a display pixel by etching etc., and the absent fraction is formed. In this absent fraction, a transparent electrode (21) caves in, a slant face is made to an orientation layer (50) by this, and it has become the orientation control ramp (25L, 25R). In the zone of the left-hand side specified by the orientation control ramp (14L, 25L), a liquid crystalline director (31) is altogether started from right-hand side, and a liquid crystalline director (31) is altogether started from left-hand side in the zone of the right-hand side specified by the orientation control ramp (14R, 25R).

[0032] The plan of the display pixel section is shown in drawing 8 . There is a strip region of an orientation control ramp (14L,

14R) along the side of the right-and-left ends of a display pixel, and the strip region of an orientation control ramp (25L, 25R) is in this and parallel in the center of a display pixel. Thus, in two zones (L, R) divided into right and left, like the 3rd example, the flat-surface projection of an orientation vector is in the status that the opposite direction was turned to, and the viewing-angle dependency of a longitudinal direction is reduced by the mean tone of both zones (L, R).

[0033] (The 5th example) In this example, as a split means of a display pixel field, as shown in drawing 9 , the orientation control aperture (17) explained to the bottom substrate (10) in the 2nd example is formed. That is, while an orientation control ramp (14L, 14R) is formed by the bottom substrate (10), an electrode absent fraction is formed by etching into a lower transparent electrode (11), and opening of the orientation control aperture (17) is carried out. Thereby, as for the orientation status separately controlled by the both sides of a display pixel by the orientation control ramp (14L, 14R), the boundary is fixed by the orientation control aperture (17).

[0034] Since the slanting electric field which are shown by the dotted line of drawing in a liquid crystal layer (30) in the field corresponding to an orientation control aperture (17) arise, together with an operation of an orientation control ramp (14L, 14R), in a left zone, a liquid crystalline director (31) is altogether started from right-hand side, and all are started from left-hand side in a right zone. The plan of the display pixel section is shown in drawing 10 . There is a strip region of an orientation control ramp (14L, 14R) along the side of the right-and-left ends of a display pixel, and the strip region of an orientation control aperture (17) is in this and parallel in the center of a display pixel. In two zones (L, R) divided into right and left by the orientation control aperture (17), like the 3rd and the 4th example, the flat-surface projection of an orientation vector is in the status that the opposite direction was turned to, and the viewing-angle dependency of a longitudinal direction is reduced by the mean tone of both zones (L, R).

[0035] Next, the 6th example of this invention is explained, referring to the drawing 11 and the drawing 12 . Drawing 11 is a cross section of the liquid crystal cell of the perpendicular orientation ECB method concerning this example. The transparent electrode (101,111) of ITO is prepared on two transparent substrates (100,110) stuck up and down on both sides of the liquid crystal layer (120). The transparent electrode (101) is upheaved in the periphery section which it is placed between the lower parts of a lower transparent electrode (100) by the insulator, and encloses a display pixel as an orientation control fault (102S). The transparent electrode (111) is upheaved in the fraction which it was placed also between the lower parts of an upper transparent electrode (111) by the insulator, and, on the other hand, met the diagonal line of a display pixel as an orientation control fault (112S). Each orientation control fault (102S, 112S) is formed by etching SiNX, SiO2, etc. On a transparent electrode (101,111), the perpendicular vacuum evaporationo layer and polyimide layer of SiO are covered by the whole surface, and it has become the orientation layer (130,140). A liquid crystal layer (120) is a nematic liquid crystal with the negative dielectric constant anisotropy, and is controlling the initial orientation of a liquid crystalline director (121) by the excluded volume effect of an orientation layer (130,140) perpendicularly to a contact front face. The orientation layer (130,140) serves as the orientation control ramp (103,113L, 113R, 113U, 113D) toward which the contact front face with a liquid crystal layer (120) inclined [the slant face of the fraction which upheaved by the orientation control fault (102S 112S)] (refer to the drawing 12).

[0036] A drive of the cell of this structure leans the liquid crystalline director (121) of each other in the field of right-and-left both sides in the periphery section of a bottom electrode (101) to an opposite side according to an orientation control ramp (103). Moreover, it is leaned by the orientation control ramp (113L, 113R) also in the center section of a top electrode (111) to an opposite side, respectively. That is, while all liquid crystalline directors (121) are leaned by operation of the orientation control ramp (113L, 103) of the upper and lower sides whose liquid crystal layer (120) was pinched in the zone on the left-hand side of drawing 11 for the continuum nature of liquid crystal to right-hand side, all liquid crystalline directors (121) are leaned in a right-hand side zone] by operation of an orientation control ramp (113R, 103) by it, to left-hand side. Thus, while a display pixel is divided into two or more zones where an orientation vector is different by arranging an orientation control ramp (103,113L, 113R), it will be in the uniform orientation status in each zone.

[0037] Drawing 12 is a plan of the display pixel section, and shows the structure as which the opposite fraction of vertical two electrodes (101,111) was regarded from the top. The periphery of a display pixel is enclosed, there is a strip region of a lower orientation control ramp (103), and the X character type field of the orientation control ramp (113L, 113R, 113U, 113D) formed in the bottom along with the diagonal line of a display pixel is situated in the interior. ****** is the flat-surface projection of the orientation vector in halftone, and it is considered that liquid crystal die ****** is in this status on the average about a whole floor tone. In addition, the orientation of the arrow head expresses the orientation to which a liquid crystalline director leans the bottom. In four zones (U, D, L, R) divided vertically and horizontally by the orientation control ramp (113L, 113R, 113U, 113D), an orientation vector is turned in each four orientation so that clearly from drawing. Namely, from the same initial perpendicular orientation status, a liquid crystalline director is an vertical and horizontal zone (U, D, L, R), and is leaned in each four orientation. In addition, although the operation explained in the top using drawing 11 was related with the cross section of an L-R field in drawing 12 , it cannot be overemphasized by that there is an operation with the same completely said of the cross section of U-D region.

[0038] By such cellular structure, about the check by looking from the left of space, while the gradation of a zone (L) approaches white from the check by looking from a transverse plane, in order that the gradation of a zone (R) may approach black, a synthetic light of the mean tone of both zones (L, R) and a vertical zone (U, D) approaches a check by looking from a transverse plane. Since there is an equalization operation with the same said of the check by looking from other directions, a viewing-angle dependency is reduced about all directions.

[0039] Moreover, by controlling the orientation status of a liquid crystalline director in this way, the boundary line of a field which has a mutually different orientation vector, i.e., disclination, is fixed to the X character type field of an orientation control ramp (113L, 113R, 113U, 113D) about all pixels, and dispersion for every pixel is suppressed. The 7th to 10th example of this invention which controlled the orientation of a liquid crystalline director by the orientation control ramp, divided the display pixel into the plurality, and reduced the viewing-angle dependency as a liquid crystal layer like the 6th example hereafter about ECB liquid crystal cell of perpendicular orientation structure using the nematic liquid crystal with the negative dielectric constant

anisotropy is explained.
[0040] (The 7th example) Since this example is similar to the 6th example, a detailed explanation is omitted. Drawing 13 is a cross section of the cellular structure. Differing from the 6th example shown in drawing 11 is the point that the orientation control aperture (114) which is an electrode absent fraction is formed into the transparent electrode (111) along with the diagonal line of a display pixel instead of the orientation control ramp at the top substrate (110). Opening of the orientation control aperture (114) is carried out by etching etc. after membrane formation of ITO. In the field corresponding to an orientation control aperture (114), the electric field do not arise in a liquid crystal layer (120), or it is feeble, and since it is below the drive threshold of liquid crystal, the liquid crystalline director (121) is being fixed to the early orientation status. Therefore, the boundary of both the zones where an orientation vector is different is fixed by the orientation control aperture (114), and the orientation status controlled by the orientation control ramp (103) from the periphery of the display pixel section is divided by the continuum nature of liquid crystal.
[0041] In addition, although the orientation control aperture (114) has the absent electrode, the electrode exists in the field of the transparent electrode (101) of the bottom which counters this. For this reason, in the liquid crystal layer (120) corresponding to an orientation control aperture (114), the electric field arise in the orientation of slant in a configuration which is shown by the dotted line of drawing 13 . Although orientation of the liquid crystalline director (121) which has a negative dielectric constant anisotropy is carried out in the orientation of the electric field in the right-angled orientation, an inclination is caused so that it may be suitable in the orientation right-angled to the electric field by the shortest from the initial orientation status. That is, in the field corresponding to the edge on the left-hand side of an orientation control aperture (114), a liquid crystalline director (121) is leaned to right-hand side, and a liquid crystalline director (121) is leaned to left-hand side in the field corresponding to the edge on the right-hand side of an orientation control aperture (114). Therefore, in this way, while all liquid crystalline directors (121) are leaned [in the zone on the left of an orientation control aperture (114)] together with an operation of an orientation control ramp (103) by preparing an orientation control aperture (114) in a top substrate (110) to right-hand side, together with an operation of an orientation control ramp (103), all liquid crystalline directors (121) are leaned [in the zone on the right of an orientation control aperture (114)] to left-hand side.
[0042] A plan is shown in drawing 14 . the 6th example shown with drawing 12 in each zone (U, D, L, R) divided into four by the orientation control aperture (114) formed in the X character type -- the same -- the initial perpendicular orientation status that a liquid crystalline director is the same to four each -- it is leaned to orientation Therefore, since it is recognized by the mean tone of each zone (U, D, L, R) to the check by looking from all directions, a viewing-angle dependency is reduced, and dispersion in disclination is suppressed, and display quality improves.
[0043] (Example of the octavus) The cross-section structure of a cell is shown in view 15 . The transparent electrode (101,111) of ITO is prepared on two transparent substrates (100,110) stuck up and down on both sides of the liquid crystal layer (120). The orientation control fault (102L) formed in the great portion of display pixel section and the 2nd orientation control fault (105) formed along with the diagonal line of the display pixel section on an orientation control fault (102L) are prepared in the lower part of a lower transparent electrode (101). On both transparent electrodes (101,111), the perpendicular orientation layer (130,140) which consists of the perpendicular vacuum evaporationo layer and ******** layer of SiO is covered by the whole surface. A transparent electrode (111) caves in relatively in the periphery section among which an orientation control fault (102L) surrounds a display pixel for a transparent electrode (101) with ********** on the whole, a slant face is generated on an orientation layer (130), and the fraction with an absent orientation control fault (102L) serves as the orientation control ramp (104). The 2nd orientation control fault (105) upheaves a part of transparent electrode (111), and the orientation control ramp (106L, 106R, 106U, 106D) is formed (refer to the drawing 16).
[0044] A display pixel field is divided into the zone of the left-hand side specified by the orientation control ramp (104,106L), and the zone of the right-hand side specified by the orientation control ramp (104,106R). That is, in a left-hand side zone, all liquid crystalline directors (121) are leaned to left-hand side according to an orientation control ramp (104,106L), and all liquid crystalline directors (121) are leaned [in a right-hand side zone] to right-hand side.
[0045] The plan of the display pixel section is shown in drawing 16 . The strip region of an orientation control ramp (104) is in the periphery section of a display pixel, and the X character type field of the orientation control ramp (106L, 106R, 106U, 106D) formed along with the diagonal line of a display pixel is situated in the interior. Thus, in each zone (U, D, L, R) divided into four, a liquid crystalline director is leaned in each four orientation from the same initial perpendicular orientation status, and the flat-surface projection of the average orientation vector expressed with ****** has turned to four orientation.
[0046] By such cellular structure, about the check by looking from the left of space, while the gradation of a zone (L) approaches black from the check by looking from a transverse plane, in order that the gradation of a zone (R) may approach white, a synthetic light of the mean tone of a zone (L, R) and a vertical zone (U, D) approaches a check by looking from a transverse plane. Since there is an equalization operation with the same said of the check by looking from other directions, a viewing-angle dependency is reduced about all directions.
[0047] Moreover, by controlling the orientation status of a liquid crystalline director in this way, the boundary line of a field which has a mutually different orientation vector, i.e., disclination, is fixed to the X character type field of an orientation control ramp (106L, 106R, 106U, 106D) about all pixels, and dispersion for every pixel is suppressed.
(The 9th example) That this example differs from the example of the octavus is the point that the orientation control ramp (115L, 115R) is prepared in the top substrate (110), as a split means of a display pixel, as shown in drawing 17 . It is placed between the lower parts of a lower transparent electrode (101) by the orientation control fault (102L) formed in the great portion of display pixel section, and the periphery section is them with the orientation control ramp (104). An orientation control fault (112L) is prepared in the whole surface, and the absent fraction is formed in the lower part of an upper transparent electrode (111) along with the diagonal line of a display pixel by etching etc. In this absent fraction, a transparent electrode (111) caves in, a slant face is generated on an orientation layer (130), and it has become the orientation control ramp (115L, 115R, 115U, 115D). In the zone of the left-hand side specified by the orientation control ramp (104,115L), all liquid crystalline directors (121) are leaned to

left-hand side, and all liquid crystalline directors (121) are leaned [in the zone of the right-hand side specified by the orientation control ramp (104,115R)] to right-hand side.

[0048] The plan of the display pixel section is shown in drawing 18 . The periphery of a display pixel is enclosed, there is a strip region of an orientation control ramp (104), and the X character type field of the orientation control ramp (115L, 115R, 115U, 115D) formed along with the diagonal line of a display pixel is situated in the interior. Thus, in each zone (U, D, L, R) divided into four, like the example of the octavus, while the flat-surface projection of an orientation vector is in the status that each four orientation was turned to and a viewing-angle dependency is reduced by the mean tone of each zone (U, D, L, R) about all directions, dispersion in disclination is suppressed.

[0049] (The 10th example) In this example, as a split means of a display pixel field, as shown in drawing 19 , the orientation control aperture (107) explained to the bottom substrate (100) in the 7th example is formed. That is, while an orientation control ramp (104) is formed in a bottom substrate (100), the electrode absent fraction is formed by etching into a lower transparent electrode (101). By this, as for the orientation status separately controlled by the both sides of a display pixel by the orientation control slot (103), the boundary will be fixed by the orientation control aperture (107).

[0050] Since the slanting electric field which are shown by the dotted line of drawing in a liquid crystal layer (120) in the field corresponding to an orientation control aperture (107) arise, together with an operation of an orientation control ramp (104), in a left zone, all liquid crystalline directors (121) are leaned to left-hand side, and all are leaned [in a right zone] to right-hand side. The plan of the display pixel section is shown in drawing 20 . The periphery of a display pixel is enclosed, there is a strip region of an orientation control ramp (104), and the X character type field of the orientation control aperture (107) formed along with the diagonal line of a display pixel is situated in the interior. In each zone (U, D, L, R) divided into four by the orientation control aperture (107), like the octavus and the 9th example, the flat-surface projection of an orientation vector is in the status that each four orientation was turned to, and a viewing-angle dependency is reduced by the mean tone of each zone (U, D, L, R) about all directions, and dispersion in disclination is suppressed.

[0051]

[Effect of the Invention] It was able to divide into two or more zones which have the priority viewing-angle orientation which is different in a display pixel, respectively by having arranged the orientation control ramp into the predetermined fraction of a cell so that clearly from the above explanation. Therefore, in TN cell, by dividing a display pixel into right and left, the viewing-angle dependency which was high to the longitudinal direction was made low, and the display of a wide-field-of-view angle has been realized. Moreover, in the perpendicular orientation ECB cell, while the wide-field-of-view angle was realized by dividing vertically and horizontally, the occurrence of uneven disclination different for every pixel was prevented, the rough deposit of a screen was lost, and display quality improved. Furthermore, since a pre tilt angle becomes unnecessary, while the rubbing process of an orientation layer is cut down and a manufacturing cost is reduced, static electricity produced at the time of rubbing is lost, and the electrostatic discharge of TFT is prevented.

[Translation done.]

CLAIMS

[Claim(s)]
[Claim 1] In the LCD which comes to arrange the display pixel by which two substrates with the transparent electrode were stuck up and down on both sides of the liquid crystal layer, and were formed in the opposite front-face side in the opposite section of these two electrodes in the shape of a matrix The LCD characterized by preparing the orientation control ramp formed by upheaving or collapsing partially the contact front face with the aforementioned liquid crystal layer in the periphery of one [at least] aforementioned display pixel of the aforementioned electrode or/, and the field, and controlling the orientation of liquid crystal by this orientation control ramp.
[Claim 2] The aforementioned orientation control ramp is a LCD according to claim 1 characterized by being formed of the orientation control fault prepared in the lower part of the aforementioned electrode when the aforementioned electrode upheaves partially.
[Claim 3] The aforementioned orientation control ramp is a LCD according to claim 1 characterized by having been prepared in the field of the aforementioned display pixel, having divided the aforementioned display pixel into two or more fractions, and changing the orientation of the liquid crystal of each fraction of the divided aforementioned display pixel.
[Claim 4] The LCD according to claim 1 characterized by controlling further the orientation of the liquid crystal which the orientation control aperture formed of the absence of an electrode was prepared in the field of one [at least] aforementioned display pixel of the aforementioned electrode, and was controlled by the aforementioned orientation control ramp.

[Translation done.]